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Development of Geopolymer and geopolymer-based composites

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Abstract: Geopolymers and related composites have some advantages like low-temperature preparation, simple processing proc ESS like resin-based composite and forming complex shape components, low cost, light, heat resistant, flame retardant, cor Rosion resistant, sound solid sealing for nuclear waste and heavy metal for energy ions and COSaving >2 emission reduction. They can be thus used in conventional construction, metallurgy and related fields. Geopolymer can be modified by doping to obtain the functional properties such as conductivity, electromagnetic shielding, Stealth and others. Meanwhile, after high-temperature treatment, Geopolymer and its composites can be converted into leucite and leucite-based Composites with controlled mechanical and thermal properties, showing potential as a applications Low-cost Structural material for aerospace, heat-resistant components and stealth materials. This review summarized recent development of Geopolymer and its composites, and the aspects dealt with geopolymerization m Echanism and microstructure evolution of Geopolymer, structural design, preparation technology and performance Eristics of Geopolymer Composites, and application in 3D printing and nuclear waste. In addition, the future development of Geopolymer field was also given.

Keywords: geopolymer geopolymerization mechanism composites; 3d printing; nuclear waste immobilization

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An aluminum silicate polymer is a kind of for inorganic polymers , Its research started with century 70 era , first by French scientist Joseph , davidovits [1-3]. the Aluminum Silicate polymer is made up of al 0 4 and Si 0 4 tetrahedron cells cross-linked by mutual oxygen The three-dimensional network structure , metal cations such as Li + , Na + ,K + or Cs+ are distributed in its network pores to balance the four-match aluminum atoms negatively charged , to implement the system charge balance [1-3] . aluminum silicate poly The outstanding feature of the composite is low temperature preparation , High temperature service , Its primary force Learn performance indicators with traditional ceramics , resin and aluminum alloy materials phase compare to, and low thermal conductivity [0.24~0.38 W /(m+K)], Low density (2.2 ~ 2 . 7 g/cm 3), Heat-resistant , fire-retardant and heat-free poisonous gas , available on to ~ 1 ,, ° C Stable use , is an ideal heat-resistant knot construct material ; also , Aluminum Silicate polymers for low energy consumption , C 0 2 Low Emissions , is a green environmental material [4] , so in building , metallurgy , Aerospace and defense fields have a wide range of applications before view [5] . current , French aluminum silicate Polymer Institute , US-Iraq Lee-No university of Champagne, University of Melbourne, Australia , UKShffield University , Harbin University of Technology , China University

of Geosciences (North Beijing), University , Guangxi University , Southeast University , CAs Lanzhou Institute of Physical and Chemical research institutions at home and abroad in aluminum silicate polymerization The preparation process of the object , the aggregation mechanism , performance features and engineering applications The aspect has been studied and promoted in depth . at the same time , for al-Si The biggest problem in the application of acid salts polymers is brittle fracture , with low reliability , Researchers at home and abroad have also developed a variety of aluminum silicate Salt polymer matrix composites to solve this dilemma .

polymerization mechanism of aluminosilicate polymers , Preparation Process , Performance features , Composite toughening mechanism and application prospects The Aspect summarizes research in this area , and point out future research Focus .

1. polymerization mechanism of aluminosilicate polymers

The bias kaolin is the most commonly used in the synthesis of aluminosilicate polymers, Raw Materials , Other as fly ash [7-9] , Gold Tailings [10-11] , Pearl rock [12-14], k -feldspar [one] and red soil [15-16] Silicate Minerals , and Rock and solid waste can also be used in synthetic aluminum silicate polymers . but , compared to biased kaolin ,Other raw material composition relatively complex miscellaneous , Research on aggregation mechanism , Generally with the chemical composition of the more simple kaolin as raw material synthetic aluminum silicate polymer for Research Object . aggregation process for aluminosilicate polymers , root according to davidovits etc [17-23] The view of

can be summarized as dissolving , Expand scatter , aggregation and cure 4 procedure , Each stage involves a different transition Change Form . First in aqueous solution aluminum silicate minerals with alkaline excitation agent chemical reaction , To generate water-soluble aluminum-containing monomers and silicon-containing monomers ; dissolved monomer (as Al 0 4 and Si 0 4 Tetrahedron) to liquid phase uniform Diffuse ; at a certain temperature , between aluminum monomer and silicon-containing monomer Condensed condensation reaction to create the gel phase ; gel phase and residual reactants Dissolve diffusion and gel phase in capillary movement , Exclude remaining moisture , In the appropriate environment to further solidify the formation of aluminum silicate poly complex . Cm etc [|] the verifies that the poly The moisture that is introduced in the join process although it participates in the aggregation reaction , However , after the, the aggregation is completely discharged . duxson etc [a] workconfirm , The fully reactive polymer has a nano-like zeolite microstructure , a nano-particle separated by a nano-pore makes up a

Mr Cheung + [-|-] with infrared ,X X-ray diffraction and ambient sweep Tracing electron microscope in-situ quantitative tracking test methods revealed the aluminum silicon The formation of acid-salt polymers the entire process (build , Development and Evolution). knot fruit show : with aggregation reaction time extended , loosely stacked high Ridge soil particles gradually change to a more compact sponge-like colloid , and K2O ,Ai2o3 and Si 0 2 The scale approaches the theoretical value gradually ,simultaneous Silicon the infrared vibration peaks corresponding to the low wave number offset , aluminum atom by Initial five-and six-coordination transitions to four-matchOther , original Bit quantitative tracing and energy scattering analysis results show , aggregate reaction The only produces a sponge-like gel , does not have a rule's knotCrystal Status products [28]. Weng, etc [[] in al-Silicate ions on the basis of partial charge calculation for ions in the Regiment , Studied the mechanism of the aluminum group in the synthesis of aluminosilicate polymers , recognize for aluminum components have a significant catalytic effect on polymerization , and Lee Aluminum Silicate synthesized by small-grained kaolin with aluminum components The Salt polymers have a shorter curing time , more homogeneous microscopic knot refactoring and higher mechanical strength .

to overcome the effect of impurity elements in natural kaolin . , Wang mei Honor etc [+] Preparation of aluminum silicate with synthetic kaolin as raw material polymer ,the aggregation mechanism of the system is studied , After the aggregation reaction is found , The five-and six-bit of the kaolin in the "" A1 Atom completely transition to four in the configuration Unit form , and Si atom with Q4 (3 A1) and Q4 (2a1) structure cell form ,

and gives an aluminum silicate polymer empty structure model (Chart 2).on the basis of the above research results ,et [ ] for The first time Reaction termination control method , applied to aluminum silicate study on polymerization mechanism of salt polymers , is used to precisely control its aggregation time , and using IR spectrum , NMR , local charge mode The type method combines the scanning analysis system to illustrate the aluminum silicate poly The aggregation process of the complex . when biased kaolin powder and alkaline silicate Solution Mix , The first dissolves from the surface of the particles , that is, aluminosilicate Salt powder, Si structural units Q 4 (1A1) and four , Five and six collocation AlAtomic structure unit dissolve , makes the Si - O - Si the key and Si - o-al key hydrolysis fracture , Forms [Al(OH) 4]-, [A 1 O (*) () () () () [] (OH) 3]2-,[Al (OH) 4(oh 2)]-[Al (OH) 5]2- , [Al(OH) 4(OH2) 2]-, [Al(OH) 5 (OH2)]2- and [SiO(OH) 3]- primary monomer and less Quantity [SiO2 (OH) 2]2- monomer . with reaction , Four coordination increased content of aluminum atoms , Other coordination number aluminum atom content by fade , when reaction 6 H after , completely converts to four-match aluminum atoms , as table 1 : ; and each monomer has a condensation reaction between each other , Remove the water molecule , eventually generate a Si to Q4 (3 Al) Structural Unit form exists,Al all exist in the form of a four-ligand atomic structure Unit Network-like hybrid structure of amorphous aluminum silicate polymers , With microstructure changes from loose pores at the initial stage of aggregation to late all Uniform dense morphology .

also ,The also systematically studies the graphene oxide (go) Effect of polymerization mechanism of aluminosilicate polymer , find go the can be restored in situ in an alkali-stimulated solution , and facilitated the initial phase (0 ~ min) Al transition from atomic to quad-coordination units and Si Original child to Q 4 (3Al) Build cell generation , but did not change the aggregation output Object type , composite polymerization process schematic diagram 3 is shown in . this outside , , go add aggregate product particles to a greater degree , Products has relatively rugged appearance .

Study on polymerization mechanism of aluminosilicate polymers , is currently more Many still remain in the description of the reaction process , just respond to procedure is generally divided into dissolved , diffuse , condensation Phase . but effect mechanism on final structural factors of aluminosilicate polymers Research also lacks depth , such as aluminum silicate polymer structures in a large number of [SiO4] structural units , corresponding to different coordination structures ,

How to adjust the proportions between various coordination modes and the various coordination modules The mechanism for transformation and evolution between the and is not known yet ; aluminum silicate poly The ion size of the anti-Hengyang ions in the complex structure , charge density to The control mechanism for the on its own structure remains to be deepened ; in the reaction system the specific role of water molecules throughout the aggregation process is also not clear . to on a series of problems that currently exist should be more micro-perspective analyzing The whole polymerization process , to enable the production of inorganic polymers The control of the final structure of the object .

2. Preparation of aluminosilicate polymers and their composites Prepare process and performance

2.1 Preparation process for aluminosilicate polymers and their composites

due to the excellent rheological properties of aluminosilicate polymer slurry and adjustable ,

Simultaneous preparation can be done at room temperature , and low curing temperature (+~ - ° C), therefore aluminum silicate polymers and their composites Preparation process can draw on common cement and resin preparation process include casting , suppresses molding and recently developed 3 D Print, and so on , The advantages and disadvantages of the process are shown in the table 2.

1) pour method .

The pouring method is the most commonly used preparation method for aluminosilicate polymers , that is convert aluminum raw materials , alkali activator , solvent blending , get a certain Liquid slurry , then pouring the slurry into the mold . This side the Law also applies to particles , nanotube , Short Fiber modified aluminum

silicatepolymer composites . Yan etc ,Yuan , and Lin and so on, take this a pure aluminum silicate polymer was prepared by the process , and carbon nanotubes [a] , Graphene [%, 3"[1] [2], alumina particle [%], short carbon fiber [A] , Short Carbon Silicone Fiber [[] And so strong aluminum silicate polymer composites .

3 D The cost of printing . Xia etc [a] Adopt the Powder printing method (schematic See figure 4), The aluminum silicate polymer powder level by layer (about 0.1mm) Passover binder solution selectivity (DoD) glue , Pass subsequent threads order Remove Binder , get 3D print widget . results show : Preparation of alumina silicate polymer material obtained sufficient printability , has good printing accuracy , available for powder 3 D To print . but the biggest problem with this approach is that the binder is removed after the , will be in the material Leave a lot of pores , affect their mechanical properties . in Xia and so on experiments , sample porosity up to 57.1%, This direct guide The compressive strength of the printed cubic component is only 0.9 MPa , far not meeting actual application requirements .

He Peigang in 3 D More research has been made in the direction of printing results . Research Discovery : Add a quantity to an aluminum silicate polymer The plasticizing agent of can significantly improve its rheology and plasticity , to apply to different alkali metals (Na , K) excitation and aluminum silicate with different silicon/aluminum ratios Compliance System , has universality . the compressive strength of the printed component of the is able to reach ~MPa, This indicates that 3D Print is completely applicable to al-Si acid salt polymer system . on this basis , hit special ceramics research investigate 3D Preparation of graphene modified aluminum silicate by printing process polymer composites , print schematic and composite macro-shape Look like " 5 " [$] .

also , Mr Cheung + [%] A short is prepared by extrusion PVA Fiber-reinforced aluminum silicate polymer composites , This method works with the 3D printing process similar to .

is currently , Aluminum Silicate polymers, especially composites, The main focus is on the more traditional pouring and pressing methods , and 3D print , RTM, -Wrapping etc preparing complex shape artifacts The application of the method in aluminum silicate polymer materials is in the beginning or not yet involved stage , How to control aluminum silicate aggregation The composition of the material to meet the requirements of these molding processes will be the future of to focus on .

2.2 properties of aluminosilicate polymers and their composites

Many factors affect the performance of aluminosilicate polymers , includes silicon Aluminum raw material activity [+], aluminum ratio [a] , alkali metal ion type [%] etc . Wang Meirong wait [more] study raw material calcination temperature to aluminum silicate effects of polymer mechanical properties , Find 9⑻°C after burning the deviationkaolin has higher chemical activity , ie raw material four-match [A1] O4] Highest content , The prepared aluminum silicate polymers are compared with the and ° C ° Flexural strength of materials prepared by calcined kaolin , anti-pressure degrees and thermal conductivity respectively increased 269%, 52% and 378%. duxson etc [next] compares the ratio of silicon to aluminum to 1.15 ~ 2.15 potassium for excitation and sodium-excited aluminum silicate polymer conservation 7 and top d with strong degree Changes, Research shows that : in the range of the component mechanical strength and play The modulus increases with the increase in the ratio of silicon to aluminum . Zingyu etc[one] on aluminum silicate polymer process , with sodium hydroxide and potassium hydroxide as the main excitation of alkaline alkali to excite gold tailings get aluminum silicate polymerization Objects . Research Discovery : use potassium hydroxide more than sodium hydroxide excitation helps increase the compressive strength of such materials . knven wait [+] with warm Preparation of aluminum silicate polymers by isostatic pressing process , Comparison of hydrogen and oxygen sodium and potassium hydroxide different mixtures of molar ratio materials the mechanical properties of the material "" can , found that when the mole fraction of potassium hydroxide is 30% to50% , Aluminum silicate polymer reaches maximum compressive strength With The hydroxide continue increase of potassium content , material polymerization rate and curing rate Rate Increase , The pore size and porosity of the pores are also gradually mentioned in the material. high . He Peigang etc [$] research shows : with base metal cation radius Plus , High temperature softening

temperature point of aluminosilicate polymers , Heat tolerance increase ; with silicon aluminum ratio 2 raise to 4, Although its force Learn performance significantly increase , But the melting point is significantly lower , and wind resistant The effect significantly drops . Court Jingkun et, [[] Research shows that : when extended Maintenance Time ,, Increase temperature of maintenance , Aluminum silicate Polymer Materials The mechanical properties of the material appear first up and down again , in the curing temperature is - C under Curing D Has the highest compressive strength , for 124.8 MPa , is much better than the currently used cement material . addition , Compared to cement, Aluminum silicate polymer with excellent chemical resistance corrosion capability , anti-freeze-thaw cycling and anti-infiltration features , This makes it to seal various chemical wastes , Toxic heavy metal ions and nuclear radiation element , etc substitution cement has great application potential [] .

Aluminosilicate Polymers also have a series of disadvantages , includes :

1) Curing time difficult to control, performance for aluminosilicate polymer raw materials Add water after mixing the coagulation rate is more difficult to control, No form similar to water mud-ripe curing control system , This has adverse effects on molding and construction ring , has great impact on its bulk industrial applications ;2) solidify shrink Large , The behaves as an aluminum silicate polymer from pouring molding to solidification over The bulk shrinkage in the process is greater , especially when preparing bulk materials volume contraction more obvious and cause cracking ; 3 potential base - aggregate reaction risk , main performance under certain service conditions , Aluminosilicate The alkali metal ions in the salt polymers and the active components in the aggregates Reaction generation inflation - Low strength silicate products , cause cementitious material - aggregate interface off , Results in a sharp drop in material performance . Develop a suitable multifunctional additive body for aluminum silicate polymer material system Department , is the key to addressing these disadvantages , and apply for its engineering The lays the groundwork for .

Although aluminum silicate polymer materials have low temperature forming , Low to this , Low density , Fire-retardant , Green A series of benefits , in building , traffic ,Aerospace and Defense fields as a flame retardant , hot parts are a concern , But during its application , Current the biggest problem with is its inherent fragility . , Low strength and low toughness ,, severely restricted in the need of a certain load-carrying capacity , requires high reliability wide application in the field of High-tech materials ,so it needs to be strong toughening . due to the polymerization of aluminosilicate polymers at lower temperature , so , The range of choices for the strong phase is unprecedentedly high , makes it easy to use multiple strong components such as metal particles (Chrome) , tantalum etc), Ceramic particles , Short Fiber , Whisker , carbon nanotubes and continuous fibres dimension to be strong , toughening , can also avoid direct ceramic issues , make it mechanics , Thermal and thermal performance and performance stability to design optimizations in a wider range . commonly used for strong phase mainly includes particles , graphene , carbon nanotubes , short fiber , evenContinue fiber .

Table 3 for different kinds of second-phase modified aluminum silicate polymers complex The main mechanical performance indicators for the composite materials . from table 3 to see , Fiber The dimension has the most robust effects . also , short fiber and continuous fiber introduction of , not only significantly improve the mechanics of aluminosilicate polymers performance , and break mode from brittle fracture to pseudo plastic sex break .

1) Carbon nano-Tang aluminum silicate polymer composites .

MacKenzie , and so on [70-71] Study of single-walled carbon nanotubes modified aluminum properties of silicate polymer composites , found carbon nanotubes plus into increased conductivity of aluminosilicate polymers , but mechanical properties has little effect . saloumeh etc [a] studied multi-walled carbon nanotubes (MWCNT) Effect of content on mechanical properties of composite materials , result table Ming : in MWCNT is evenly dispersed under conditions , Carbon nanotubes up to suppressing micro-crack propagation , on Add 0.5% (quality divided Count)mwcnts when , composite compressive strength and flexural strength enhanced 32% and 28%. khater etc [A] ^ $]studied mwcnts effects on slag alumina silicate polymer mortar properties . results show :

when MWCNT content 0.1% mechanical performance up to to highest , At the same time, the drying shrinkage and water absorption rate of the composites are also clear show Lower ; when the heat treatment temperature is up to C , Compositeshrinkage only 0.1%, significantly lower than aluminosilicate polymer matrix .

application of carbon nanotubes in aluminosilicate polymers major problems is hard to scatter , Improving the dispersibility of carbon nanotubes is getting high-performance complex The premise of the combination material is . Bi etc [+] Through the carbon nanotube surface to generate Si 0 2 coating enhances its dispersion , make composite flexural strength and compressive strength increased 181.2% and 21.7%; and aggregation reaction procedure Si 0 2 Coating and alkali activator in aluminosilicate polymers reaction , make CNT restores the conductive property and forms a good 3 D Conductive networks , to get ideal self-inductance structural material . Court Jingkun [[]Study on surface carboxyl-Modified multi-walled carbon nanotubes (mwcnts) Content performance effects on aluminosilicate polymers and their ceramic products . junctionresults show , Surface carboxyl modified multi-walled carbon nanotubes can be evenly distributed in aluminosilicate salt polymers , and introduces the mwcnts to to improve mechanical properties of aluminosilicate polymers , when mwcnts content 3% Peak (Chart 6). 950 °C high heat treatment , aluminum Silicate polymer matrix occurs in ceramic formation of white stone phase , Machine Mechanical performance can be further enhanced , and 1 C To maximum , this The is mainly attributed to the densification of the matrix as well as carbon nanotubes and white stone The appropriate interface between the substrates is combined with the .

2) graphene reinforced aluminum silicate polymer composites .

compared to carbon nanotubes , Graphene has a smaller nanometer size , more easily disperse in aqueous solution . Saafi etc [|] The effect of the oxide stone on the electrical properties of fly ash based aluminosilicate polymer was studied . research shows : graphene oxide can be NaOH solution First Revert to Graphene , When graphene oxide content is 0.35% , Material material conductivity from 0.77 s.m -1 to the 2.38 s.m -1.

carbon nanotubes and graphene belong to nano-materials , in al-Si application Challenges in acid salts polymers are mainly decentralized , How to get High concentration and dispersion of nano-phase modified aluminum Silicate poly complex is a hotspot in this field . wait [Use oxidation graphene easy to disperse in aqueous solution , alkaline environment and high temperature treatment can be Restore features , and aluminum silicate polymers synthesized in aqueous solutionenvironment and high temperature processing ceramic features combined , successfully prepared in-situ reduction of graphene reinforced aluminum silicate polymer composites And graphene reinforced stone garnet ceramic matrix composites , and System Research The reduction mechanism of graphene oxide , its response to aggregation and mechanics Performance Impact . The result indicates that the [The , all]: Graphite oxide (go) in

easy to restore in situ under alkaline conditions , has long-term stability and Good dispersion . Therefore, the in-place Restore method can be used as a Simple and effective way to make a batch synthesis of graphene silicate aggregates Things nano-composites ; reducing oxidized graphene (rGO) Restore degrees increase as the temperature increases : As the temperature increases , c/o from 2.48 (go) Adding to 3.36 (rGO,, ° C); Go , add No visible shadow on the structure of aluminosilicate polymer matrix ring ,and after restore , graphite evenly dispersed in aluminum silicate In the salt polymer matrix and the two are combined well . when rGO with a amount to 0.3% when , flexural strength of composites reaches maximum 17.9 MPa; fracture toughness value with RGO increases the content of the plus , when RGO content to 0.5% up to maximum , is more than the matrix high " 61.5°%, " This is attributed to RGO The causes the crack deflection and the stone ink pull-out , as shown 7 shows .

On the basis of previous research work , This topic group uses inkjet Extrusion printing (similar to FDM), Print out graphene-strong aluminum silicon Acid-salt polymer composites , but with lower compressive strength only ? MPa , also because of the Go Join , enables the composite to have a certain conductivity , conductivity up to 1 x 2 S /m .

Nano-phase includes carbon nanotubes , Graphene Modified aluminum silicate The Future research focus of polymers focuses on giving its features sex , such as conductive , Thermal , Adsorption , Magnetism, and so on , So that it sucks wave , ion solid seal , areas such as smart roads play a role , but its mechanism issues in include conductive / thermal mechanism , Wave-absorbing mechanism , Solid Seal the mechanism is still subject to further study .

3) granular reinforced aluminum silicate polymer composites .

Preparation process of alumina silicate polymer with granular strength

Single , general use of mechanical stirring or milling process . He Peigang etc [all] Research nonporous The content of amorphous silicon oxide ceramic particles to the aluminum silicate polymer complex Composite material Performance Impact . results show : with amorphous silicon oxide included amount plus , material young modulus and flexural strength increasing large , When the silicon oxide content is 40% when , aluminum silicate Polymer's Bend warp strength 84.3 MPa, with some glass ceramics quite . This is the same as Si- O-Si The high content of the bond and the strength of the silica particles the effect is closely related to . Lin Tisong wait [6] Research - Al 2 O 3Ceramic particles effects on properties of aluminosilicate polymer composites , Results proven :CI -Aon 3 The can significantly reduce the aluminum silicate polymer due tothe free water and chemical adsorption the number of micro-cracks produced by water evaporation , from to Improve composite strength , when "-Al2" 3 content 8% when ,Composite fracture toughness to maximum 0.75 MPa +m1/2, phase

higher than aluminosilicate polymer matrix 1.7 Times .

Wang Meirong [67-68] The system studied the fly-ash ball to aluminum-silicic acid performance effects of salt polymer composites . research shows : low a fly-ash ball of the strength lowers the mechanical properties of the composite. , but its Low density , Low thermal conductivity characteristics can significantly reduce composite material The volume density and thermal conductivity of the system , And the fly ash ball to the suppression base body thermal Contraction also plays a significant role , significantly improves the composite's Thermal dimension stability .

Zhang Yao [%] The studied the content of graphite powder on aluminosilicate polymers effects of composite mechanical properties and wave absorbing properties ,research shows : when Graphite with 40% when , composite flexural strength to maximum value , and at this point the electromagnetic reflection loss of the composite material reaches its maximum value. to -64.8 DB (See diagram 8), and heat-resistant temperatures up to 1 ° C , Table to state the potential application of such materials in the field of heat absorbing coatings .

compared to fiber , particle modified aluminum silicate polymer composites the mechanical performance improvement of is not obvious , and cannot prevent compositedamage hard to destroy , So it cannot be used as a structural part under tensile stress ; But their preparation process is simpler , and smaller particle size ratio to avoid composite material caused by thermal mismatch during heating material microcracks , make it better heat-resistant , So in the Heat protection coating layer , Heat resistant coating , and Heat- resistant/ / Absorbing coating field with potential apply foreground , but the evolution of organizational structure and performance at elevated temperatures and the The interface compatibility of the coated body with the is still subject to further study .

4) Short fiber reinforced aluminum silicate polymer composites .

preparation process for short fiber reinforced aluminum silicate polymers including single layer Impregnation method and mechanical ball mill stirring method . Lin Tisong wait [4m8] Take Ultrasonic assisted monolayer impregnation Study on the effect of short fiber content and length on aluminum properties of silicate polymer composites . Research indicates that : short fiber join , improves mechanical properties of composites , when fiber dimension content 3.5% (volume score), length is 7 mmwhen , compound material flexural Strength , fracture toughness and fracture work ratio aluminum silicate poly

The objects are increased by 4.4, 10.6 and 118.0 Times , and all the duplicate

All materials exhibit non catastrophic fracture characteristics , Strong for composites toughening mechanisms including microcracks toughening , fibre bridging and unplugging (- diagram 9); Fiber Surface electroless Plating Ni - P coating can effectively improve matrix and fiber Interface Binding strength [44], with Ni - P increased coating thickness , Complex The mechanical properties of the materials appear to rise first and then lower. ; establishes a model for predicting the mechanical properties of composites , calculate critical fiber dimension length and content , and against bend strength , modulus of elasticity and break work to make a prediction , Predictive value has a good match with experimental results .

He Peigang [a] Short Silicon carbide is prepared by mechanical stirring method fiber reinforced aluminum silicate polymer composites . results show : length is 5 mm With a content of 2.0% (Volume fraction) composite Mechanics performance Optimal , and exhibit ductile fracture characteristics . wait [81-82] Mining aluminum silicate polymerization with carbon fiber and sic fiber mixed reinforcement material composites , Study fixed carbon fiber length (7 MM) and different carbon Effect of silicon fiber length on mechanical properties of composite at room temperature and high temperature ring . The result shows that : The introduction of SIC fibers significantly improved the composite material Material Antioxidant properties and high-temperature mechanical properties , via $~ 1 C empty gas Atmosphere High temperature treatment ,Individual carbon fiber strong aluminum silicate polymer carbon fiber completely oxidized in composites , Composite performance is dramatically lower Drop , and 2 Hybrid reinforced composites have high mechanical properties , sic fibers can still play a strong and strong role , maintains the composite's integrity . Ng etc [a] by introducing steel fibres into aluminosilicate polymers dimension to improve its clipping performance , results show : When increasing the steel fiber volume score , composite shear performance increased significantly , This is because The addition of steel fibers inhibits crack propagation in composites , and compound The rate and width of crack propagation in the material are lower in the fiber volume fraction is relatively fast . Zhang wait [$] prepared with extrusion technology short polyvinyl alcohol (PVA) Fiber /Aluminosilicate Polymer material , significantly improves impact toughness of composites , when fiber volume fraction is 2% up to to maximum 1 833 mJ , Simultaneous addition of fibers to make the original aluminum silicate The brittle fracture mode of the salt polymer improved to ductile fracture mode .

relative to continuous fiber , Short Fiber modified aluminum silicate polymer 's preparation process is simpler , So the relevant research is broader , Mesh Prior to There are reports of the above kinds of short fibers for modified aluminum silicate polymerization things . compared to organic fibres , inorganic fibres such as carbon fiber , sicfibers can not only significantly improve the mechanical properties of aluminosilicate polymers can , and thermal properties such as anti-shock , Aspects of thermal stabilityalso have a significant improvement , so the application foreground is broader . however High temperature , because aluminum silicate polymers shrink and inorganic fibers basic Keep stable , can cause a large number of microcracks in the composites , from causes composite application reliability to deteriorate , How to improve fiber and Thermal compatibility between aluminum silicate polymer substrates Sex , The will be an important fundamental scientific issue in the study of the series of composites .

[1] Suppress Molding method .

This method refers to the aluminum silicate solid component with an alkaline liquid Ingredient Mix get billet , then under a certain pressure 5 ~ Ten MPa Suppress Molding . is similar to pouring , This method also applies to a single grain , nanotube , Short Fiber modified aluminum silicate polymer composite material . also , When second phase is preform such as short fiber preform , two-dimensional fabric when , the Pouring method is used to prepare alumina silicate mine paste , then dipping preform , after design size , Mining Use pressed molding to prepare composites . Jia Jianhai etc [+] Take thisparty to prepare compressive strength up to 180~ MPa Aluminum silicate for polymer ,Lin , and so on , He , and Yuan , such as using this process to prepare out high-strength short carbon fiber [47-50] , short sic fiber , continuous carbon fiber [5i-53], continuous sic fibers [i],

Stainless steel net [+] etc strong toughened aluminum silicate polymer composite material .

[2] 3 D Print Molding .

3 D Print as a new rapid prototyping technology , has a high precision , High complexity , without abrasives , Molding Quick Advantages , Ability create complex artifacts not manufactured by traditional methods , can be applied to space , medical , Building , Electronics and other industries . aluminum silicate polymer cryogenic molding , rheological behavior controllable properties make it very useful for 3 DTo print , The low cost of the material also helps reduce the